Advanced Coating to Mitigate Hydrogen Embrittlement in High Temperature Environments, Phase I

Completed Technology Project (2018 - 2019)

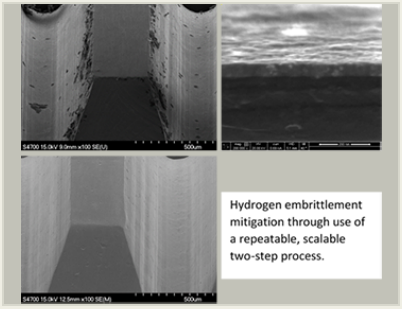
Project Introduction

The failure of metallic parts due to hydrogen embrittlement has been a constant challenge for many industries for decades, and for NASA in particular. The hydrogen embrittlement problems endemic to industries that require heavy use of hydrogen have been solved in various ways. Most of these solutions involve the careful development of alloys that are less susceptible to hydrogen embrittlement. Unfortunately, these alloys often require a sacrifice of some other highly desired material property, such as strength, hardness, ductility, etc. Coatings have also been attempted. However, these coatings and coating techniques have their own drawbacks, which include ceramic coatings that flake off after only a few use cycles and coating techniques that cannot deposit onto a finished part because they require line of sight during deposition. To better mitigate the very pressing hydrogen embrittlement challenge, Summit Information Solutions, Inc. proposes the use of a mature deposition technique that has not seen much use outside of the microelectronics industry. A thin film encapsulate will be deposited onto test samples of Inconel 718 and A-286 austenitic stainless steel. The coating material has a melting temperature in excess of 5500 °C, and is non-reactive with hydrogen. The coated samples' properties will be tested, and the results will be compared to those of the untreated samples. Summit's goal for Phase I is to show that the surface treatment is a robust layer at elevated temperatures. The extensive hydrogen embrittlement tests will be conducted in Phase II of the project.

Anticipated Benefits

The success of this feasibility study for a hydrogen embrittlement mitigation layer will have a wide breadth of NASA applications. Several NASA applications that will benefit from the development of this technology include test stand components for engine testing, long term storage of hydrogen in storage vessels, nuclear thermal propulsion applications on the newly developing NTP program, because our proposed surface layer also shows literature evidence of radiation protection, among others.

Hydrogen embrittlement is a challenge for all industries that require the use of hydrogen around metallic surfaces. The coating we are proposing has seen some initial use in the nuclear industry in reactor vessels. However, traditionally the individual parts must be coated and then joined. This produces seams that are left unprotected after joining. Our deposition technology will allow this already in-use coating technique to be utilized without the drawbacks of piecemeal coating of the parts.



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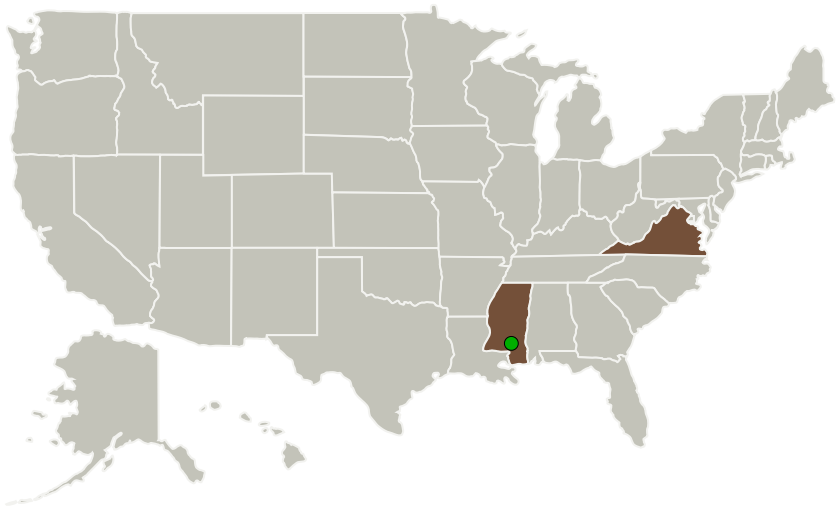
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Summit Information Solutions, Inc.	Lead Organization	Industry Women-Owned Small Business (WOSB)	Glen Allen, Virginia
Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations	
Mississippi	Virginia

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Summit Information Solutions, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

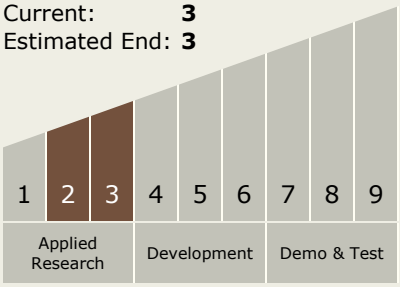
Carlos Torrez

Principal Investigator:

Dustin Winslow

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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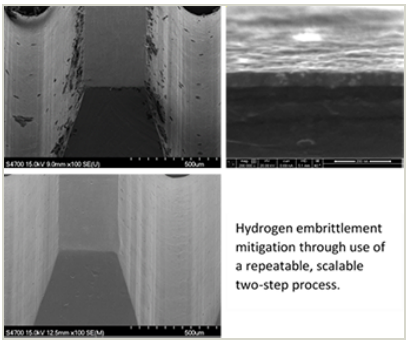
February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141236)*

Images



Briefing Chart Image
Advanced Coating to Mitigate Hydrogen Embrittlement in High Temperature Environments, Phase I
(https://techport.nasa.gov/image/130756)

Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.1 Infrastructure Optimization
    - TX13.1.1 Natural and Induced Environment Characterization and Mitigation

Target Destinations

Earth, The Moon, Mars